be effectively dealt with in the limits of an ordinary letter. I propose therefore to deal with the subject in a special article to be written shortly.
A. E. H. Love.

St. John's College, Cambridge, December 3.

Gravitation.

May I ask Dr. Joly whether Newton himself did not point out that a graduated tension excited by matter in a continuous inextensible medium, of an intensity proportional to the mass and the inverse distance, would account for gravitation; and whether he did not refrain from further elaborating this idea because there seemed at that time no adequate way of explaining the existence of such a tension?
Oliver J. Lodge.

"Outlines of Quaternions."

May I make a short explanation on one or two points on which my reviewer (Nature, November 22) does not appear to have understood me?

(1) I mentioned Prof. Hardy and Dr. Odstrčil's names in one or two places, because I quoted their language verbally. I found it was better than any language I could devise.

(2) The extraordinary oversight on p. 76 would never have seen the light had I had either good health, or the assistance of a friend, in correcting the proofs of a MS. which was written at odds and ends of time, at places as widely separated as Norway, Gibraltar, and India.

(3) My reviewer says eq. 8 of p. 40—$i = \sqrt{-1}$—"plays sad havoc with one's very definitions." Having defined i as a right versor on p. 37, and explained on p. 39 that i^2 means ii, I deduced in the usual manner the eq. —$i^2 = -1$, or—

$$ii = i^2 = -1 = \sqrt{-1}\sqrt{-1}.$$

Hence I concluded that $i = \sqrt{-1}$; and I fail to see how I have played havoc with my definitions in doing so. Had I begun by explaining that Hamilton built up his system by treating $\sqrt{-1}$ as a right versor perpendicular to the line it operates on, I might have been open to criticism; but I did not do so. I took another course, which may not have been the best one; but that is a different thing from violating one's own definitions.
H. W. L. Hime.

24 Haymarket, S.W., November 26.

[A pointed reference to a scientific writer usually implies one of three things—that the writer is an authority on the particular subject under discussion, or has made a noted discovery in connection with it, or has been guilty of a serious blunder. Dr. Odstrcil's corollary hardly comes under the second category, and Prof. Hardy's statement differs in no essential word from Hamilton's own language in the "Lectures" (p. 83).

Equation 8 (p. 40, in "The Outlines of Quaternions") asserts the equality of $i, j, k, -i, -j, -k$, and as these symbols are by definition all different, the said equation is inconsistent with the definitions. To speak of $\sqrt{-1}$ as an indeterminate right versor, that is, an operator which rotates any vector through a right angle about an indeterminate axis—a most difficult operation for the mind even to imagine—may be permitted as a figure of speech; but to equate this backboneless thing to a real unit vector or right versor with all its powers of action, is making a serious demand upon the credulity of the student. After *defining* i, j, k as symbols involving both axis and angle, what right or reason has Colonel Hime thus arbitrarily to annihilate the axis? Is it not playing havoc with the very props of the calculus?—The Reviewer.]

THE WARBLE FLY.[1]

It is only within comparatively recent years that much attention has been paid to the insect pests of the farm and garden. It is true that when these assume unusually devastating proportions, especially when they make their appearance suddenly, as in the case of locust-swarms, the attention of whole nations is called to them for the moment; but the loss caused by less obtrusive creatures may proceed unchecked and almost unsuspected for years, without attracting the notice even of those who suffer from it most. But there are now many entomologists, among whom Miss Ormerod deserves special notice in England, and Prof. Riley in America, who have been working zealously for years to diminish the loss and injury caused by injurious insects; and the pamphlet before us, with its clear descriptions and statistics, and excellent illustrations, conveys a mass of information, in a very handy form, which certainly deserves the most serious attention of all who are interested in the cattle and leather trades, whether as graziers, butchers, or tanners.

The total loss caused by the warble fly in the United Kingdom alone is estimated at something like £8,000,000 per annum; an enormous amount, but which the facts given in Miss Ormerod's pamphlet fully appear to bear out. When hides are sometimes so deteriorated that the loss on each may be as much as from twenty-five to thirty shillings, to say nothing of hides rendered utterly worthless; cattle killed, or the best parts of the carcase destroyed, and diminished yield of milk, the importance of the matter becomes very apparent. And beyond this, there remains a very serious question which Miss Ormerod has not touched upon at all: how far the milk of badly-infested cows, or the apparently sound portions of a carcase, even when all the obviously diseased part has been conscientiously removed, may be liable to cause disease in man—disease, possibly, of a nature the origin of which is at present absolutely unknown and unsuspected by medical men. And yet we remember once to have met with the statement that the best hides generally contained warbles. This, however, if true in any sense, could only mean that the fly attacks the strongest and healthiest animals in preference to weaker ones, thereby of course increasing the mischief produced by its attacks.

Although the insect is so abundant that as many as 500 maggots have been found in a single hide, yet the fly is rarely seen. When the cattle are attacked by it, they gallop wildly about, with their tails in the air, and seek the shelter of trees or sheds, or rush into the water; and in any of these situations, the fly does not appear to follow them. Cattle will act in the same manner when attacked by true gad-flies, one of the largest British species of which, *Tabanus bovinus*, is likewise noticed and figured by Miss Ormerod in her pamphlet. The gad-flies, however, simply pierce the skin of the cattle, and suck their blood, but inflict no permanent injury; and their larvæ are subterranean, and not epizootic.

According to the observations of Prof. Riley in America, the egg of the warble fly is deposited on, and not under, the skin. In the earliest stage of the maggot, which Miss Ormerod has herself observed, it is a small blood-red worm-like creature, scarcely visible to the naked eye, embedded in a slight swelling, composed of blood-red tissue, through which a fine channel, no wider than a hair, passes up to the surface of the skin (Fig. 1). In the very young stage, the maggot, which always rests with its head at the bottom of the sore, and the breathing apparatus, which is at the opposite extremity of the body, directed towards the opening which communicates with the external air, is provided with two forks or diggers, probably used for piercing through the substance of the hide. In this stage, too, the maggots are capable of inflating themselves with fluid which they have apparently no means of discharging, and become so hard that they can scarcely be compressed with the fingers, thus forming living and growing plugs, which act the part of setons, and which cannot be pressed back out of the wound, more especially as they are furnished with short bands of prickles along a portion of the back. Having penetrated the hide, the

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[1] "Observations on Warble Fly or Ox Bot Fly (*Hypoderma bovis*, De Geer)." By Eleanor A. Ormerod, F.R.Met.Soc., &c. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1894.)

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maggot rests in the sore, and presently assumes a more pear-shaped form.

When about one-third grown, a great change takes place in the structure of the creature, which, while it was forcing its passage, was "little more than a bag of fluid, with a large proportion of the space *occupied by breathing-tubes*." At this stage, however, "the hard tips necessary, or at least serviceable for forcing a passage up the hide, are no longer needed, and they are exchanged for a broad form of spiracle, and the internal organs become suited to provide material for the development of the fly, which will presently form in the dry husk of the maggot, which serves as the chrysalis-case."

The further development of the maggot is so well known that we scarcely need trace its course until it reaches its final shape of a hairy two-winged fly, not very unlike a small humble-bee in general appearance, nor need we go into the elaborate accounts of the enormous loss which is frequently caused by it to all persons interested in living or dead cattle. The fly appears to be found in most parts of the world, but is a much greater pest in some countries than in others; and it is worthy of notice that, while goats appear to suffer from the warble as much or more than cattle, horses seem never to be attacked by it.

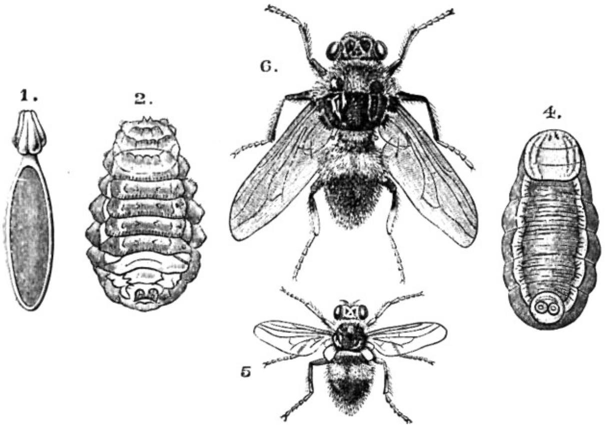

FIG. 1.—*Hypoderma bovis.* 1, egg; 2, maggot; 3 and 4, chrysalis-case; 5 and 6, fly; 3 and 5 natural size, after Bruey Clark; the other figures, after Brauer, and all magnified.

Miss Ormerod, however, gives several easy, harmless, and efficacious methods by which the mischief may be abated or removed; and the fly appears to be sluggish, and not to stray far from where it lived as a maggot, for after a few years' careful destruction of the maggots, the pest seems to disappear, without the farm being liable to fresh incursions from surrounding farms where similar precautions have not been taken to exterminate the maggots. Miss Ormerod has evidently done her best to show the farmers how they may best exterminate the pest; and if they do not avail themselves of the information which she has been at so much trouble to collect and to disseminate, it will not be her fault. The accompanying illustration is from her useful pamphlet.

W. F. KIRBY.

FERDINAND DE LESSEPS.

THE death of M. de Lesseps, on Friday last, removes from the world one of its more prominent men. To say that it was his indefatigable energy which brought to a successful termination the scheme to pierce the Isthmus of Suez, is but to repeat what is known to every schoolboy. With the affairs that during the last two years have obscured his fame to the political eye we have nothing to do. The work which earned for him the title of "Le Grand Français" is sufficient to command the admiration of every man of science. The appreciative obituary notice in the *Times*, running into nearly four columns, deals largely with de Lesseps' diplomatic career, but this does not concern us. We are indebted to the notice, however, for some of the following particulars of interest to our readers.

Ferdinand de Lesseps was born at Versailles, November 19, 1805. His early public life was spent in the diplomatic service, for which he manifested the same predilections as his ancestors. But so far back as 1841, the project for cutting through the Isthmus of Suez had occurred to him. It was not until 1854, however, that he first revealed the scheme that will be most lastingly associated with his name. Two years later, Said Pasha, the Viceroy of Egypt, granted him a formal letter of concession. In the same year de Lesseps published a clear and definite exposition of his views in his pamphlet "Percement de l'Isthme de Suez. Exposé et documents officiels." Many eminent engineers questioned the practicability of the scheme; nevertheless a capital of two millions of francs was subscribed, and in 1859 the works were commenced.

Difficulties and disputes of a most serious character cropped up from time to time, but they were overcome, with the result that a canal, having sufficient water to admit of the passage of steamboats, was opened on August 15, 1865. The channel was widened and deepened by special machinery, and in March, 1867, small ships were able to make use of the Canal. The waters of the Mediterranean mingled with those of the Red Sea in the Bitter Lakes on August 15, 1869, and the event was commemorated by grand *fêtes* at Suez. On November 20 following, the Canal was formally opened at Port Said amid a series of brilliant festivities. The Canal is about 100 miles long, with a bottom width of upwards of 200 feet, and a depth of 28 or 29 feet.

Honours poured in upon M. de Lesseps after the successful opening of the Canal. In February, 1870, the Geographical Society of Paris awarded him the Empress's new prize of 10,000 francs. He gave it as a contribution to the Society's projected expedition to Equatorial Africa. He was appointed to the rank of Grand Cross of the Legion of Honour, and received the cordon of the Italian Order of St. Maurice. The honorary freedom of the City of London was presented to him, and Queen Victoria created him an honorary Knight Grand Commander of the Order of the Star of India. In July, 1873, the Paris Academy of Sciences elected M. de Lesseps a member, in the place of the late M. de Verneuil. In 1875 he published his "Lettres, Journal, et Documents pour servir à l'Histoire du Canal de Suez." For this work the French Academy awarded to him the Marcelin Guérin prize of 5000 francs. In June, 1881, he was elected President of the French Geographical Society, in the place of Admiral de la Roncière-le-Noury. The Broad Riband of the Persian Order of the Lion and the Sun was presented to him in 1883.

M. de Lesseps promoted the project of the Corinth Canal, and made a journey in Algeria and Tunis to study the scheme of Commandant Rondaire for the creation of an inland sea in Africa—a scheme of which he formed a favourable opinion. Gradually, however, he became wholly absorbed in the undertaking which was to prove his ruin—the Panama Canal. All the world knows how this ended. After the humiliating drama had been played out at the beginning of last year, the central figure sunk

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